HARKEN®

Hydraulic
Jib Reefing & Furling
Installation Manual

Unit 3.5

WARNING!: Strictly follow all instructions to avoid an accident, damage to your vessel, personal injury or death. See www.harken.com for additional safety information.

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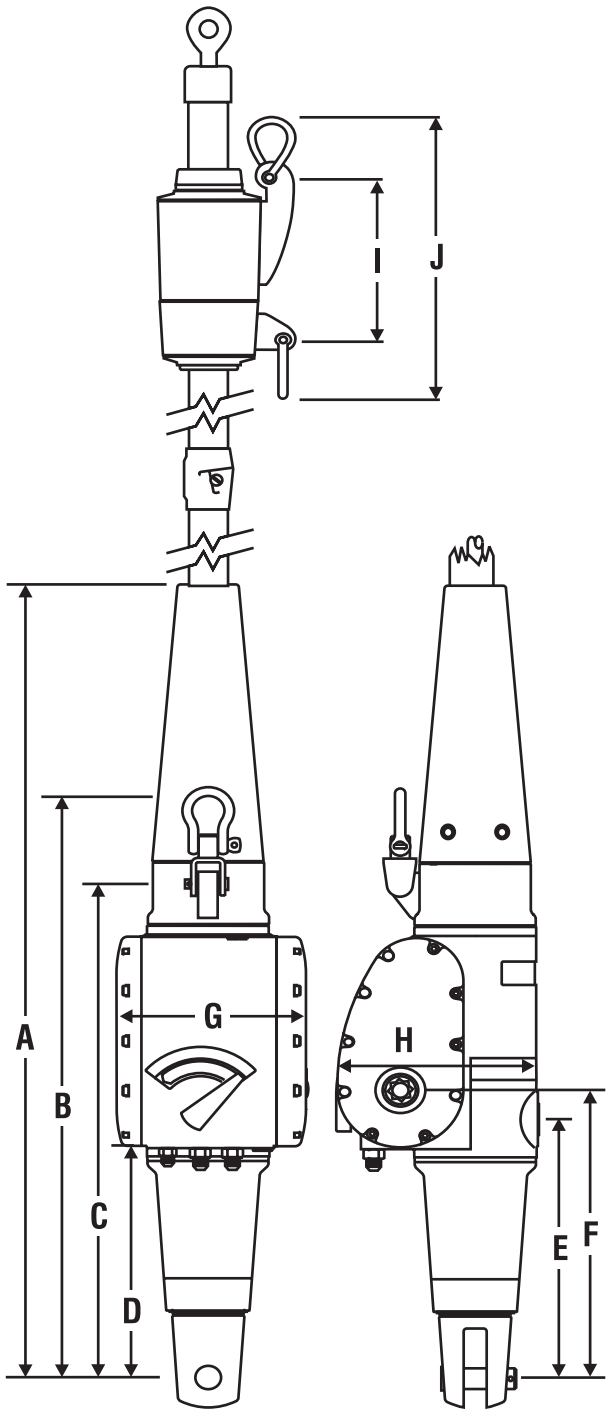
Warranty — Online at www.harken.com or call, write, email or fax Harken, Inc., Pewaukee, WI USA

DIMENSIONS - *Unit with 1" (25.4 mm) Clevis				
A	**B**	**C**	**D**	**E**
37 3/4" 959 mm	25" 635 mm	21 1/2" 546 mm	10 3/8" 264 mm	11 5/8" 295 mm
F	**G**	**H**	**I**	**J**
12 7/8" 327 mm	7 5/16" 194 mm	7 11/16" 195 mm	9 3/16" 233 mm	13 3/16" 335 mm

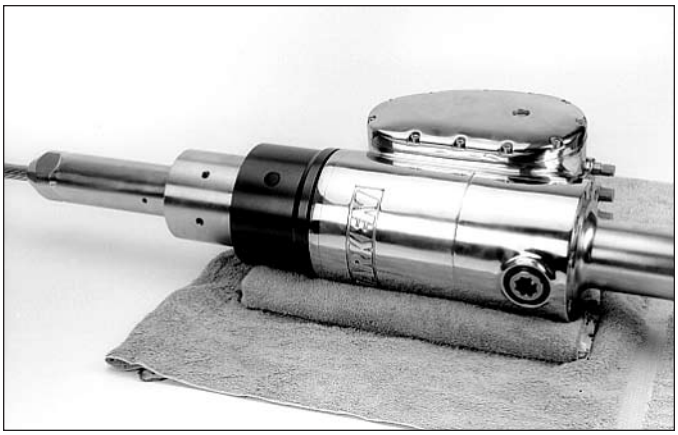
*Subtract 3/8" (10 mm) for 7/8" (22.2 mm) clevis. Add 1/2" (12 mm) for 1 1/8" (39.7 mm) clevis (A to F only).



■ STAINLESS STEEL SURFACE

Be careful not to scratch the stainless steel surfaces of the lower unit. Lay the unit on terry cloth or other soft material while assembling.

The hydraulic unit is polished stainless and does not have chrome plating. This surface can be polished using standard stainless steel polishes to maintain its appearance.



■ PORT SIDE UP

Keep the port side of the unit facing up when sitting on its side.

If the unit will sit for a long period of time, or is stored or shipped, keep the port side of the lower unit facing up. This will prevent gear oil from leaking out of a pressure relief valve.

> ***TIP:*** *When the port side is up, the sideplate with the winch handle socket will be facing down.*

If a small amount of gear oil does leak out of the valve during shipping or installation, it will drip out of the bottom of the unit when up in sailing position. Use a rag to catch this leakage.

■ HOSES

Hoses are not supplied with furler.
Use SAE 100 R1 or R2 hoses.

Sizes depend on the distance that the hoses will run and the power source. For shorter runs use:

Two Drive Hoses:	-6 (3/8" ID)
One Drain Hose:	-4 (1/4" ID)

Contact Harken for further hose size recommendations.

■ HOSE END FITTINGS

Hose fittings are not supplied with furler.
All fittings must be stainless steel. Standard attachment method uses female hose end fittings.

Furling unit end fittings have JIC 37° flair fittings.

Note: Do not use locking solution or tape on connections.

Hose end fittings sizes:

Drive fittings - JIC 9/16-18 female swivel

Drain fittings - JIC 7/16-20 female swivel

■ ALTERNATE FITTING METHOD

Remove furling unit end fittings. Use SAE straight thread O-ring male hose end fittings:

Drive fitting - 9/16-18

Drain fitting - 7/16-20

■ DRAIN SYSTEM

Besides the main hoses for forward and reverse, a fitting for a drain hose is included. The drain hose must be lead to the main reservoir in the power unit.

Power Requirements		
Size	**Recommended Flow Rate**	**Rotation at No Load**
3.5	5 GPM (16 l/min.)	50 RPM

The unit will work with any Harken hydraulic power pack. Best performance will be with the hydraulic 6 or 8 system.

See performance charts.

■ VALVES ON POWER UNIT

Furler can be used with open or closed center, 4-way, 3-position control valves.

■ MAXIMUM OPERATION PRESSURE

Set relief valve on power plant at 140 Bar or 2000 PSI. Harken power packs ship with valves set at 140 Bar.

■ OIL SPECIFICATIONS

Gear box oil - AGMA8, 90 weight gear oil
18 ounce (510 g) capacity

Note: The gear box is filled with oil at the factory. Under normal conditions there is no need to change the gear box oil.

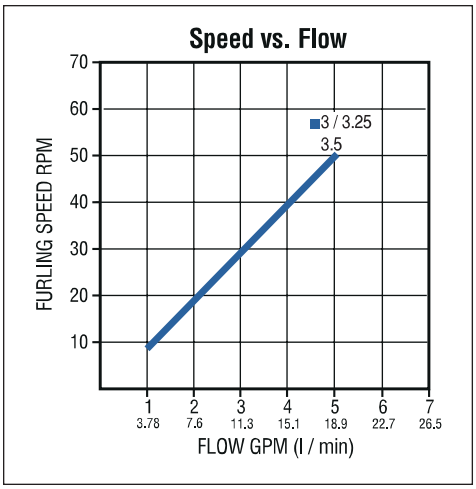
Hydraulic fluid is a petroleum based oil, ISO viscosity grade 46, anti-corrosion, anti-foam, anti-oxidant, anti-rust, anti-wear additives.

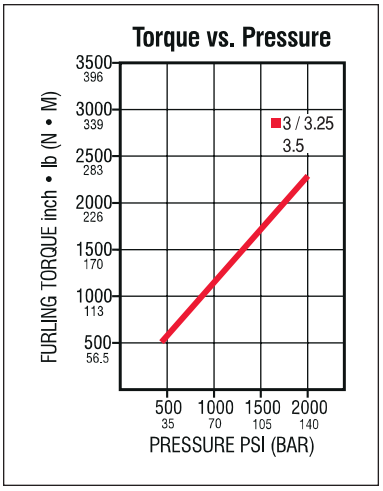
Fluid examples: Exxon Nuto, Shell Tellus, BP Energol HLP

CAUTION!: The only parts of furler to be disassembled by installer are the Torque Tube and Lower Cowling. All other work should be performed by factory-authorized personnel. Work performed by unauthorized personnel may void the Harken limited warranty.

Note: Some fluid may drip from the unit during shipping. This is normal and should stop once the unit is in its sailing position. All units are tested before leaving the factory. Units are shipped port side facing up.

Make sure unit is shipped or stored port side up. If it is not, gear oil will leak out of the pressure relief valve.





■ MAIN COMPONENTS

Halyard Swivel
Cowling
Torque Tube
Toggle

■ MAIN HOUSING

■ MISCELLANEOUS PARTS

Red Loctite	Foil Screws	Foil Wedges
Blue Loctite	Torque Tube Screws	6mm, 8mm Allen Wrench
Cross Pin	Clevis Pin	Cotter Pin
Circlip	Tack Shackle	Feeder

■ RIGGER PARTS

Trim Cap	Connectors	Long Bottom Connector

■ TERMINAL-WIRE

Nosepiece	Wedge
Main Body	Former
	Drive Pin

■ TERMINAL-ROD

Nosepiece	Drive Pin	Collar

■ FOILS

Bottom Foil	Foils

■ HEADSTAY CUT LENGTH

The following cut lengths will result in the headstay adjuster being ½ open. At this cut length, 2½" (64 mm) of adjustment will remain in the stay adjuster in either direction.

Subtract the following from the headstay length and cut the stay at that point.

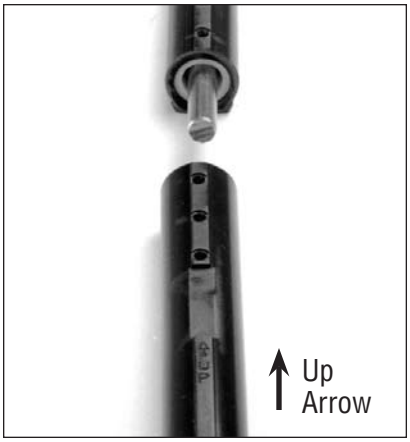
HEADSTAY CUT LENGTH CHART			
	Clevis Pin Size		
	7/8" (22.2 mm)	1" (25.4 mm)	1 1/8" (28.6 mm)
5/8" Wire	25 1/4"	25 3/4"	26"
16 mm Wire	(641 mm)	(654 mm)	(660 mm)
19 mm Wire	25 3/4"	26 1/4"	26 1/2"
	(654 mm)	(667 mm)	(673 mm)
-48 Rod	24 1/4"	24 3/4"	25"
14.3 mm Rod	(616 mm)	(629 mm)	(635 mm)

Note: The Harken hydraulic furler has an integral toggle. No additional toggle is required below the furler.

■ STRINGING CONNECTORS ON STAY

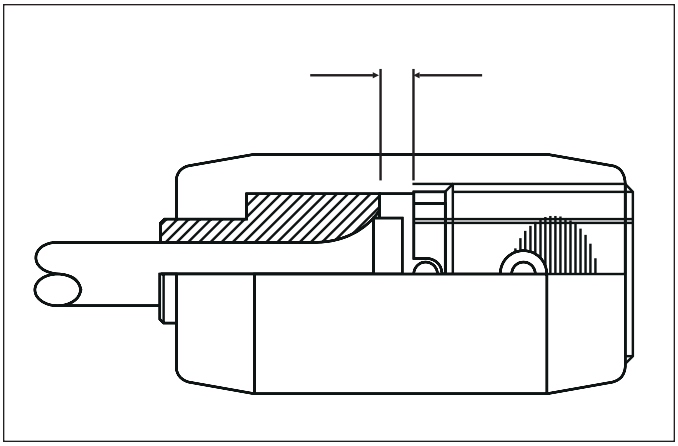
Make sure the trim cap is at the top and the correct number of connectors are used. The long bottom connector must be slid on the wire or rod so the feeder holes will be matched to the window in the foil.

Make sure the "up" arrow stamped on the front of the connector is pointing to the top of the stay.



■ -48 (14.3 mm) ROD COLDHEAD HEIGHT

Make sure the length of rod coldhead does not interfere with the drive pin. There is 3/16" (4.7 mm) between the collet bottom and the roll pin.

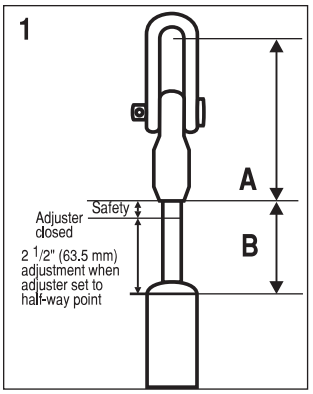


■ FOIL CUT LENGTH - UNIT 3.5

Foil cut length is based on pin-to-pin length as measured from center of upper pin (attaches the stay to the mast) to center of lower pin (attaches the furling unit to the boat). Measurement includes the masthead toggle. The hydraulic furler has a lower integral toggle. No additional toggle is required below the unit.

There must be more than 2½" (63.5 mm) of adjustment above the trim cap when the adjuster is set to the half way point. The total adjuster stroke is 5" (127 mm). (See inset 1)

To check foil length, lay foils alongside stay before cutting top foil. Set stay adjuster to the half way point.



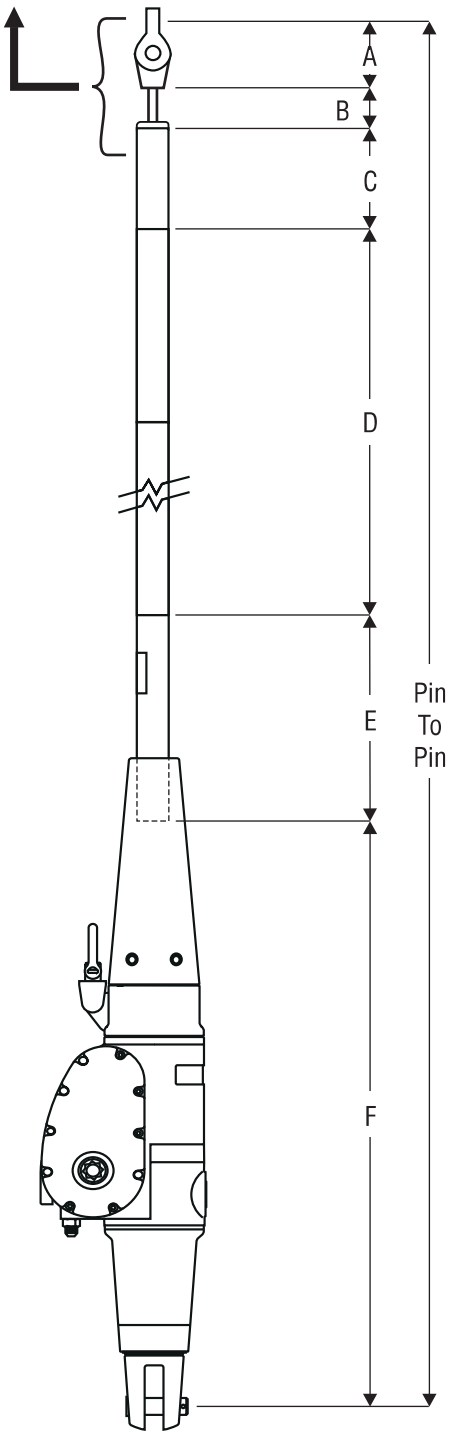
■ TOP FOIL CUT LENGTH

Instructions For Worksheet Below:

1 Fill in total pin-to-pin length.
2 Fill in A length.
3 Add A, B, E, F and subtract from total pin-to-pin length. SUM = _____
4 Choose the number from foil multiplier below closest to but not greater than, sum from step 3. Fill in D length.

*6 x 108 =	648	**6 x 2743.2 =	16459
7 x 108 =	756	7 x 2743.2 =	19202
8 x 108 =	864	8 x 2743.2 =	21946
9 x 108 =	972	9 x 2743.2 =	24689
10 x 108 =	1080	10 x 2743.2 =	27432
11 x 108 =	1188	11 x 2743.2 =	30175
12 x 108 =	1296	12 x 2743.2 =	32918

5 Add A, B, D, E, F.
Subtract from pin-to-pin length for C (top foil length).



WORKSHEET: DETERMINE TOP FOIL LENGTH		
DIMENSIONS	**INCHES**	**MM**
A Center of PIN to Bottom of Terminal	_____	_____
B Bottom of Terminal to Top of Foil	3.5	89
C Top Foil	_____	_____
D __?__ 108" (2743.2 mm) Foils (Quantity)	*_____	**____
E Bottom Foil	24	610
F Clevis Pin to Foil	34.25"	870
Total Pin-to-Pin Length	_____	_____

BEFORE CUTTING: If top foil is less than 9½" (241 mm), shorten top trim cap bushing. If this will not work, it may be necessary to shorten one of the full length foils and redrill holes.

Drill a 21/64" (8.33 mm) trim cap hole in the top foil, opposite the grooves, centered at 1¼" (31.75 mm) from the top of the foil.

■ NOTES

Unit 3.5 foils are 9' (2.743 m) long. Unit 3.5 has no feeder gap.

There must be at least 2½" (63.5 mm) of wire above the trim cap when the adjuster is set to the half way point. The total adjuster stroke is 5" (127 mm). Drill a 21/64" (8.33 mm) trim cap hole in the top foil, opposite the grooves, centered at 1¼" (31.75 mm) from the top of the foil.

■ CONNECTOR AND FOIL QUANTITY

Refer to the Top Foil Length Worksheet.

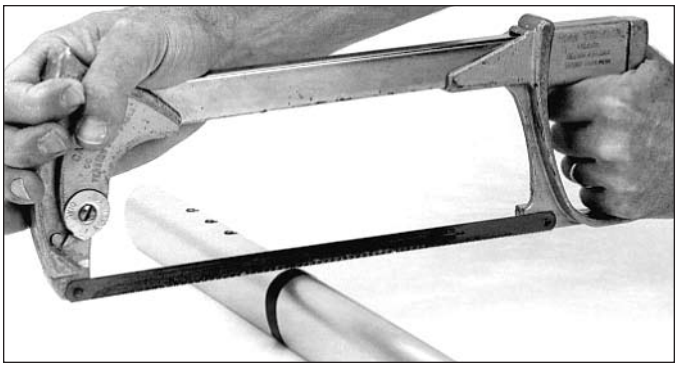
Unit 3.5 requires one fewer regular connector than number of foils. (Count top foil, but not bottom foil.) In addition, a trim cap and long bottom connector is required.

■ CUTTING TOP FOIL

Once you have checked the top foil length, cut the top foil.

Deburr and clean all shavings from the foil.

Important: Failure to deburr or clean the inside of the foil may cause it to seize to a connector when installing on rod.

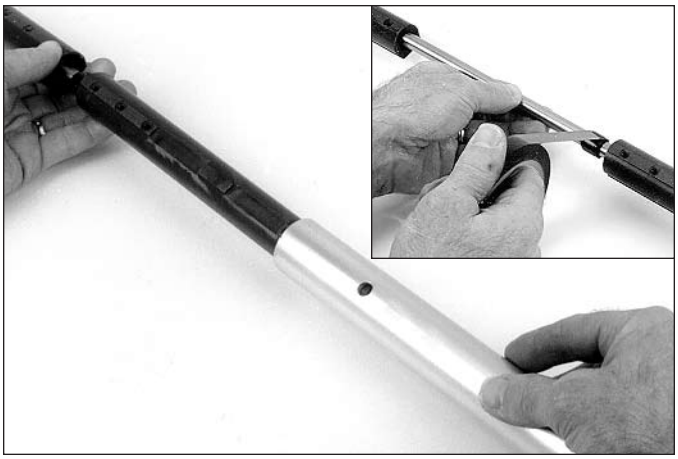


■ ASSEMBLE FOIL

Make sure you have drilled a hole in the top foil so it lines up with the hole tapped in the trim cap.

Slide top foil to top of stay, screw holes towards the bottom.

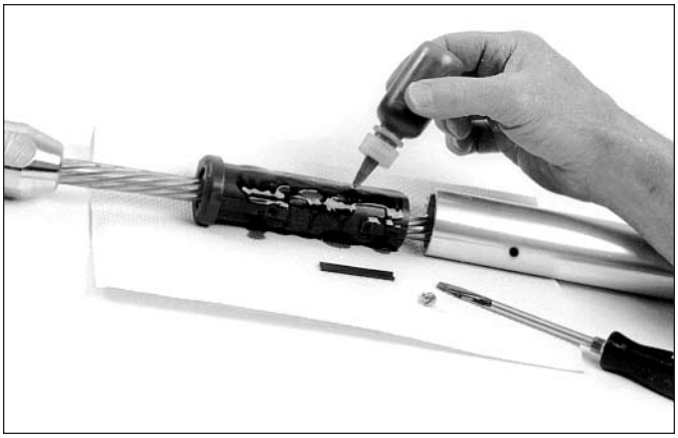
> ***TIP:*** *When working with rod, tape lower connectors in place or use a pusher wire longer than foil to hold connectors.*



Coat the trim cap top bushing with red Loctite.

Place a wedge in the indentation and insert into the top foil.

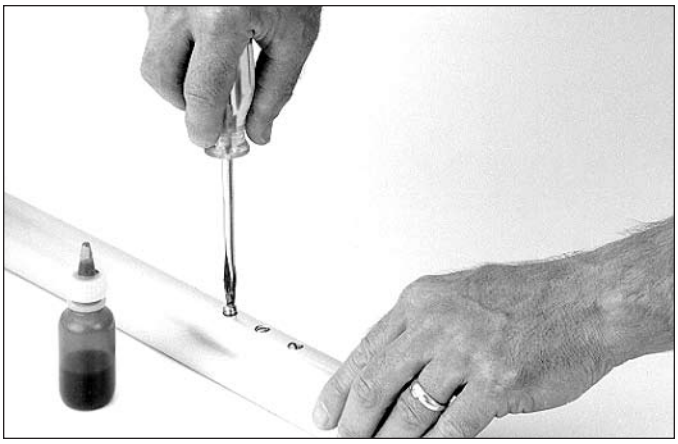
Coat a foil screw with red Loctite. Thread into connector hole.



Slide first connector to the top of the stay. Coat half of the connector and the indentation with red Loctite.

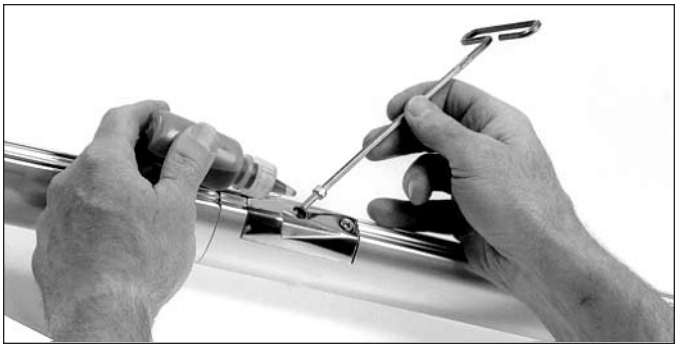
Place a plastic connector wedge in the indentation closest to the top foil.

Coat three foil screws with red Loctite®.
Screw them into the connector until tight.
Continue assembly.



Slide halyard swivel onto foil, tall end up.

Install feeder screws toward bottom, using red Loctite® on screws.



Slide torque tube onto foils.

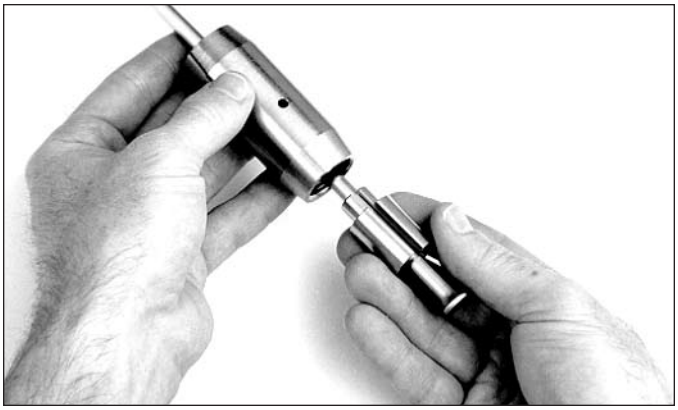
■ ATTACHING STAY TO LOWER UNIT — ROD

Use a winch handle to crank the terminal completely out of the lower unit.

Make sure halyard swivel and torque tube have been slipped on the foils.

Slip the rod adapter main body onto the rod.

Sandwich the nosepiece over the rod and insert into the main body, narrow end first. Jiggle the main body or use a small screwdriver to push the nosepiece completely into main body.



Put several drops of the blue Loctite on the large threads of the stud. Thread the stud into the main body until the slot aligns neatly with the hole in the main body.

TIP: *Sight through the pin hole to find the optimum thread engagement. Make sure the stud is threaded far enough so the pin is securely seated in the slot, yet not threaded too far to block the pin.*

Hammer the pin into the main body. Put blue Loctite on pin.

Clean excess Loctite® from the terminal body using special care to insure that no Loctite is present on the lower threaded stud.

■ ATTACHING STAY TO LOWER UNIT — WIRE

Assemble wire terminal per Sta-lok instructions.

Note: To prevent seizing nosepiece threads when forming the wires, put red Loctite on the threads to lubricate them. Open terminal up for inspection. Put sealant inside terminal.

Use a winch handle to crank the terminal completely out of the lower unit.

Apply red Loctite to the stud or the socket of wire terminal.

Clean excess Loctite off the stud below the terminal.

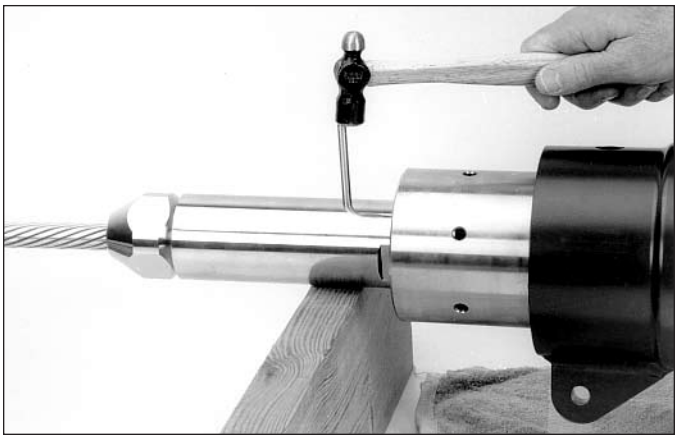
Thread the hydraulic unit onto the Sta-Lok terminal and wire.

Protect stainless steel housing and sideplates from scratching when rotating unit. Use saw horses that are padded and have terry cloth covering.

TIP: *Lift the lower unit by the tack swivel shackle and lower end of unit. Spin lower unit into Sta-Lok terminal.*

Put red Loctite on the pin and drive it into place.

Clean excess Loctite from the terminal body using special care to insure that no Loctite is present on the lower threaded stud.



■ INSTALL LOWER TOGGLE AND COWLING

The integral toggle can be installed so the clevis pin runs either fore/aft or athwartships.

Choose the correct hole in the base and use the cross pin to secure the lower toggle so clevis pin runs the correct direction.

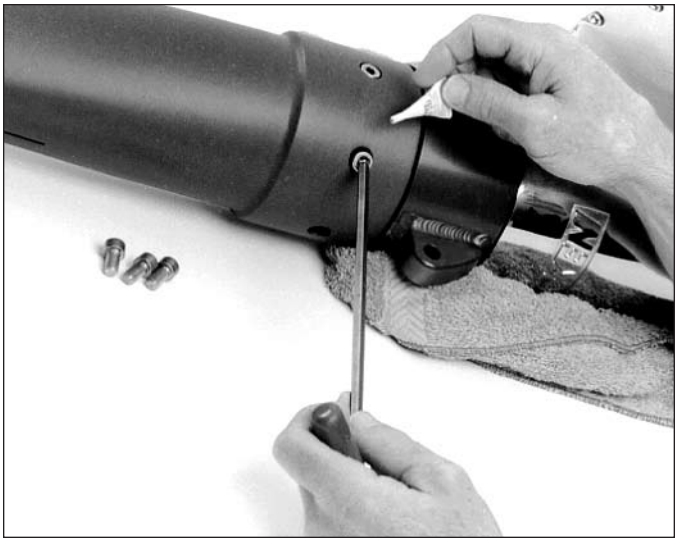
Slip the cowling in place.

Secure using the circlip provided.

■ INSTALL TORQUE TUBE

Secure the torque tube to the lower unit using the six cap screws provided. Use blue Loctite® on the screws.

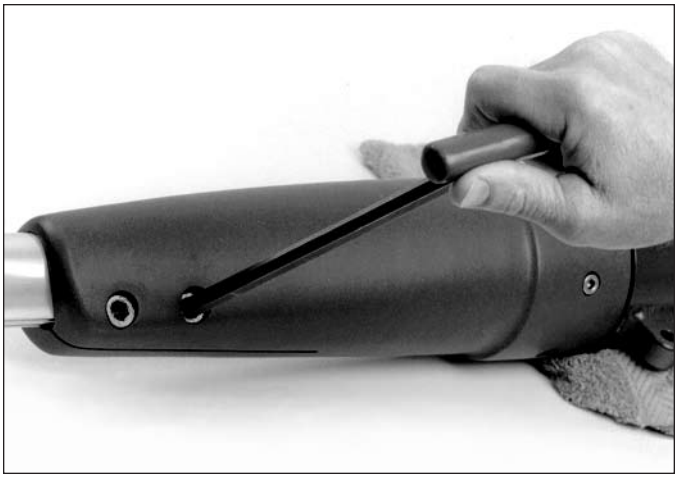
TIP: *Insert all six screws BEFORE tightening.*



■ RAISE FOILS

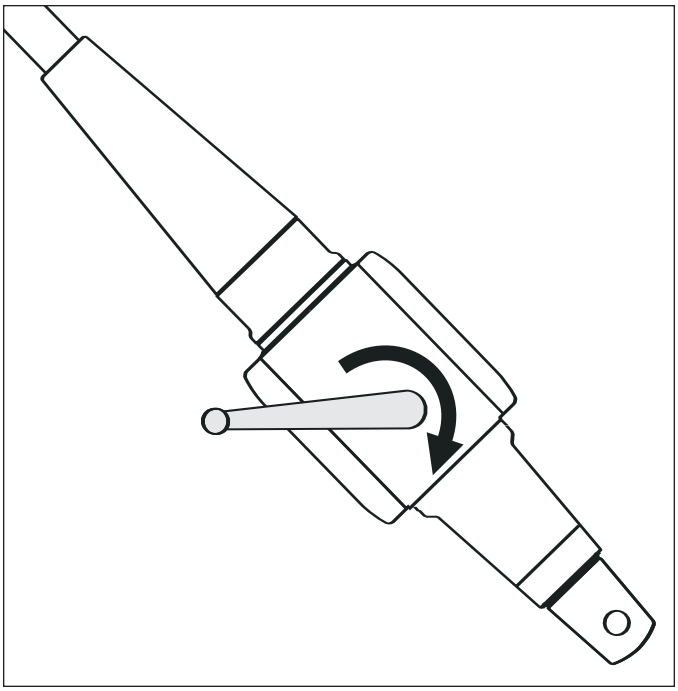
Push the foils to the correct height and use an allen wrench to secure the torque tube to the foils using the two screws provided.

Use blue Loctite® on the screws.



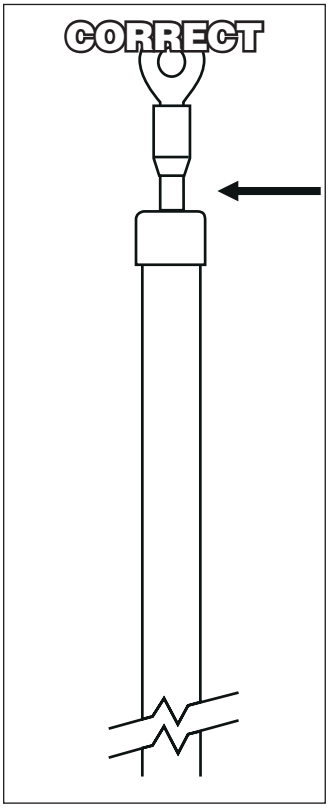
■ CHECK FOIL LENGTH

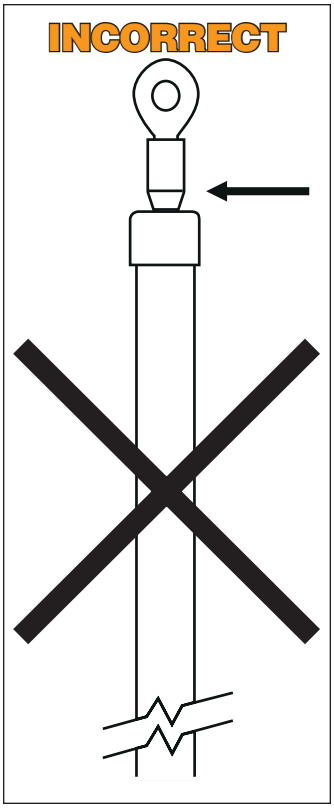
Once the foils and lower unit are assembled, use a winch handle to close the stay adjuster. Turn the handle in a clockwise direction.



Check the clearance between the top of the foil and top terminal.

> ***TIP:*** *Check clearance when the unit is on the ground, before raising the headstay into position.*





WARNING!: It is critical to have clearance between top foil and top rigging fitting when stay adjuster is in fully closed position. If fittings touch, unit will jam or in the case of a Sta-Lok fitting, terminal may unscrew. This could cause a catastrophic spar failure which may cause an accident, damage to your vessel, personal injury or death. See www.harken.com for additional safety information.

It is the responsibility of the rigger to check clearance.

■ RAISE FURLING UNIT ON MAST

CAUTION!: To prevent damage to the stay adjuster, make sure the torque tube is secured to foils and lower unit before moving unit.

If the unit will sit for a long time, make sure the port side of the lower unit is facing up.

TIP: *The sideplate with the winch handle socket will be facing down.*

Once you have closed the stay adjuster to confirm there is clearance above the foils, open the adjuster all the way.

Turn the stay adjuster counter-clockwise to open the adjuster completely. This makes it easier to connect the stay to the boat.

TIP: *Cover unit with terry cloth and padding to protect stainless finish.*

■ GEARBOX PRESSURE

It is possible that pressure has built up in the gear box during shipping.

Once the unit is in sailing position, relieve pressure by using a 6mm allen wrench to open the filler valve on top of the lower unit.

Install the cap so it is wrist tight (20 foot pounds).

■ INSTALL HOSES

Use hose end fittings which are:

Drive: JIC 9/16-18 female swivel

Drain: JIC 7/16-20 female swivel

Do not use locking solution or tape on connections.

Alternate Method: Remove furling unit end fittings and use SAE straight thread O-ring male hose end fittings.

■ CHECK GEAR OIL LEVEL

CAUTION!: Do not overfill gear oil as this will cause leaking from the breather valve which may cause damage to your vessel.

Oil can be checked from top of case. Insert a small metal stick into filler hole at top of gear housing.

Oil should be at bottom of gears. When unit is in angled sailing position, oil level will be 2" (51 mm) from top of housing.

■ ADJUST HEADSTAY TENSION

There is no need to unlock turnbuckle. If sail is up, make sure halyard is loose.

Do not adjust under sail.

Insert winch handle and rotate counter clockwise to loosen or clockwise to tighten stay. Total adjustment is 5" (127mm).

CAUTION!: When tightening the stay, if handle becomes suddenly hard to turn, stop immediately. Forcing handle when adjuster is completely closed will damage gears.

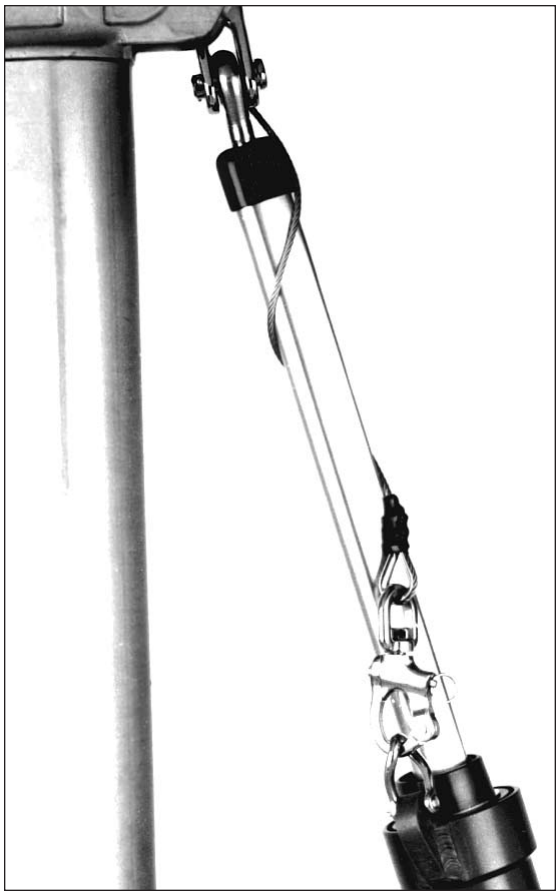
All final rig tensioning or spar bending should be done using a conventional backstay adjuster.

■ HALYARD WRAPS

The most serious problem with furling systems occurs when the jib halyard wraps around the headstay foil. Halyard wraps will prevent furling or unfurling and may cause serious damage to the unit and the halyard. In severe cases, halyard wraps may cause headstay loss.

To prevent wraps, the halyard must exert a slight pull to the rear. This allows the foils to turn while the halyard remains stationary.

WARNING!: In severe cases, a halyard wrap can cause loss of control of boat and/or headstay can break suddenly which can cause an accident, damage to your vessel, personal injury or death. See www.harken.com for additional safety information.



■ PREVENT WRAPS

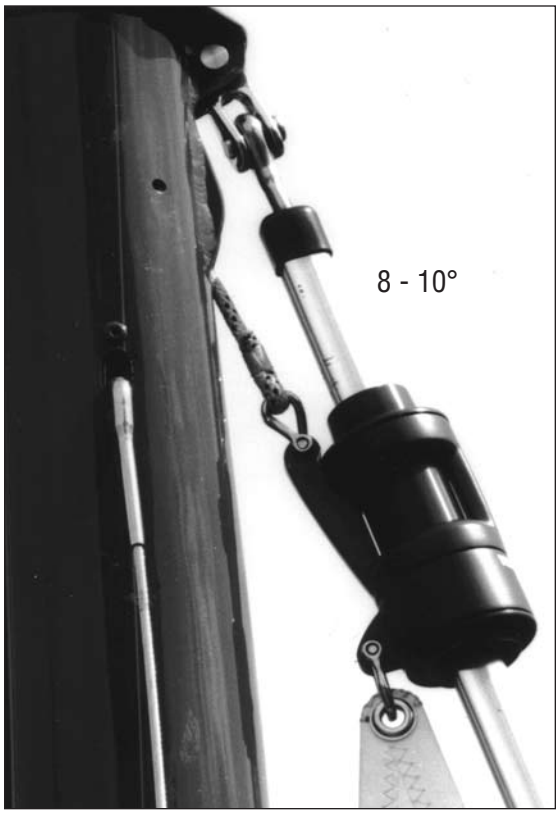
WARNING!: WARNING!: Sail must be fitted to foil length before using to prevent a halyard wrap which could lead to headstay breakage causing an accident, damage to your vessel, personal injury or death. See www.harken.com for additional safety information.

1 Halyard swivel should be within the top 4" (100 mm) of the foil.

2 Halyard must pull slightly to the rear (8 - 10°).

3 Halyard must be snug, but not too tight.

TIP: *With the sail raised, walk away from the boat and look at the masthead with binoculars. Use the halyard swivel as a measurement reference. 4" (100 mm) is ⅓ the length of the swivel. There should be less foil exposed above the swivel than ⅓ of the swivel.*



If a halyard wraps, do not force the unit to turn. Attempt to open the sail by alternately furling in and out slightly.

If the sail can be unfurled, lower the sail by releasing the jib halyard. Severe halyard wraps can only be cleared by going aloft and freeing the halyard.

If the sail will not furl or unfurl, it may be possible to remove the jib sheets and manually wrap the sail around the headstay.

Remember: Testing at the dock does not indicate the halyard angle is correct. In wave action, the halyard may wrap if the lead angle is not correct. The 8-10° diverging angle mentioned above is critical.

■ PENDANTS

If your sail is not long enough to position the halyard swivel properly, you must add a pendant to the sail. Pendants should be plastic coated wire permanently attached to the sail so the height will be correct. Adjustable length pendants are not acceptable as they might not be adjusted correctly during a sail change.

■ INSTALL A PENDANT

1. Raise the sail, but do not attach tack shackle.
2. Position the halyard swivel correctly near the top of the headstay and secure the halyard.
3. Secure a piece of rope to the sail tack. Lead the line through the tack shackle on the furling drum and tension the sail.
4. Measure the distance from the tack shackle to the sail tack and have a pendant of this length permanently attached to the head of the sail.
5. Repeat this procedure for every jib.

TIP: *Pendants are used at the head of the sail. Short pendants may be added at the tack to improve visibility under the genoa, but remember that visibility is already improved by shackling to the tack swivel. Tack pendants increase heeling moment by raising the sail plan. You may install pendants at both the head and tack of the sail.*

■ HALYARD RESTRAINER

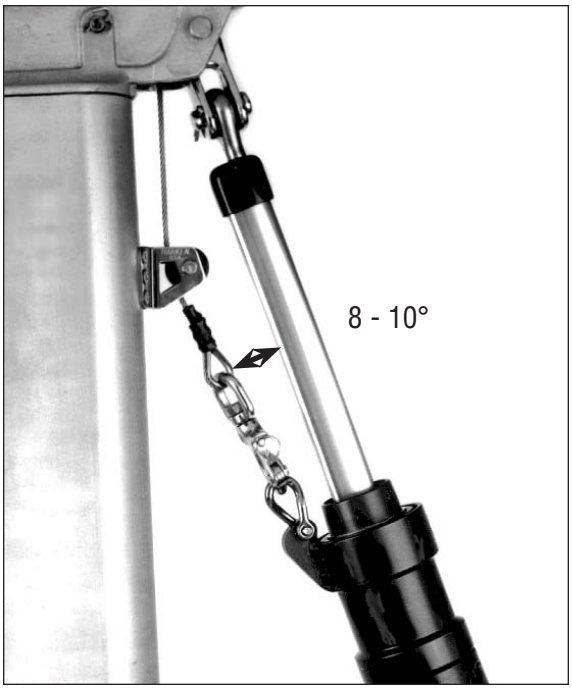
To prevent wraps, the jib halyard must pull slight to the rear. On some boats the halyard sheaves are located too close to the headstay and a halyard restrainer must be used.

Use halyard restrainers only when required by the masthead geometry. Restrainers tend to limit sail luff length and may cause problems if not properly installed.

Mount the restrainer as high as possible on the face of the mast. Position the restrainer so the foils will not hit it when under load.

The restrainer should deflect the halyard 8-10°. If the angle is more than 10°, you may experience difficulty in tensioning the sail luff, friction in furling and possible damage to the foils. To decrease deflection angles, shorten the luff of the sail.

CAUTION!: If halyard angle is more than 10°, you may experience difficulty in tensioning sail luff, friction in furling and possible damage to foils.



■ HALYARD TENSION

The jib halyard should be firm, but not too tight.

TIP: *The luff foil system supports the sail along its entire length so halyard tension is required only to shape sails, not to support them. Use only enough halyard tension to remove some wrinkles along the luff. Do not tension the halyard enough to cause vertical wrinkles in the luff. Use halyard tension to adjust draft position of the sail to suit sailing conditions. Your halyard should be firm but not tight. If in doubt, release halyard tension. To protect the sail, ease the halyard when the boat is not in use.*

■ BACKSTAY TENSION

Good stay tension helps furlers turn more easily. Make sure to ease jib halyard before tightening backstay to prevent damage to furler.

CAUTION!: Tensioning backstay without easing halyard will cause halyard to tighten excessively causting damage to halyard swivel and tack swivel.

■ BEFORE OPERATION

WARNING!: Before operating, consult pages on halyard lead angle. If sails are changed, make sure halyard lead angle is correct. A halyard wrap cannot be tolerated on a hydraulic furler In severe cases, a halyard wrap can cause loss of control of boat and/or headstay can break suddenly which can cause an accident, damage to your vessel, personal injury or death. See www.harken.com for additional safety information.

Make sure to ease sheets before operating the system.

CAUTION!: Do not use hydraulic furler to sheet sail.

The direction of furling is up to the individual. Make sure suncover is rolled correctly.

***TIP**: Label buttons "in" and "out" and be consistent in their use when rolling and unrolling sail. This way, it will be possible to furl in tdesired direction at night when sail is hard to see.*

■ MANUAL OPERATION

To furl or unfurl the unit manually, push the lever to manual and insert a winch handle in the starboard socket. Rotate to move the sail in or out.

***TIP:** Use a short 8" (200 mm) handle to increase furling speed furling.*

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Printed in USA 4904/10-08